

REMARKS

In response to the Office Action mailed July 25, 2005, Applicants respectfully request the Examiner reconsider the above-captioned application in view of the foregoing amendments and the following comments.

Claims 1-19 are pending in this application. Claims 8-13 and 18-19 were subject to a restriction requirement and have been provisionally withdrawn without prejudice.

Claim Objections

The Examiner has objection to Claim 14 because of informalities, and suggested a change. Claim 14 has been amended to incorporate the Examiner's suggestion and is believed to be allowable for the reasons stated below. Applicant wishes to thank the Examiner for pointing out this error.

Rejection of Claims 1, 4, 5, 15 and 16 under 35 U.S.C. 103(a)

The Examiner has rejected Claims 1, 4, 5, 15 and 16 under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (2002/0059708), in view of Gingerich et al. (4,135,109). The Examiner asserts that Zhang discloses a method for making a piezoelectric transducer comprising the steps of machining a ceramic blank, coating the ceramic with a metallic layer, and transforming the ceramic material forming the ceramic into a piezoelectric crystal. The Examiner admits that Zhang fails to disclose machining the hollow ceramic into a tubular configuration, but opines that this would have been obvious to one of skill in the art based on Zhang alone. In addition, the Examiner admits that Zhang fails to disclose machining a plurality

of helically intertwined outer electrodes, where each outer electrode is associated with a functionally discrete transducer segment, but that Gingerich discloses this type of helical outer electrodes.

The Applicant does not admit or deny the Examiner's arguments regarding Zhang. Instead, the Applicant can distinguish Claim 1 of the present application based on the Examiner's analysis of Gingerich.

With regard to Claim 1, Applicant's respectfully assert that the Examiner has mischaracterized the structure cited in Gingerich. Gingerich discloses a cylindrical transducer for providing an omnidirectional beam pattern in one plane, and a line radiation pattern in planes normal to the omnidirectional pattern. That is to say the transducer disclosed in Gingerich produces an energy beam that is collimated substantially perpendicular to the cylindrical transducer longitudinal axis in a radial direction. See Abstract, Col. 2, lines 18-32, and Figures 1A and 1B. For general background information, see also the description of prior art transducer in Applicant's application for Figures 3A-3E. Gingerich further discloses that in known large cylindrical piezoceramic tubes or cylinders, omnidirectional patters have been produced that are highly unsatisfactory, including patterns having higher overtones of various low frequency modes along with various cylindrical modes. See Col. 1, lines 1-23, and Figure 2.

In order to eliminate these unsatisfactory patterns, Gingerich states that it is know to slice and/or dice the piezoceramic, altering the complex mode structure and essentially completely eliminating the undesirable effects of extraneous vibration. See Col. 1, lines 24-40. Gingerich further states that this method presents a multitude of isolated elements or posts, each one of which must have adequate electrical contact for thickness mode operation. This is the problem identified

by Gingerich that must be solved, because achieving adequate electrical contact can require several-thousand electrode connections (one for each section of the segmented external electrode), depending on the way the length of the piezoceramic cylinder is sliced and diced. See Col. 1, lines 24-40.

To overcome the stated problems, (undesirable effects and multitude isolated elements each requiring a separate electrical connection) Gingerich discloses cutting a spiral groove or thread into one surface, for example, the outer surface, of the transducer. See Col. 2, lines 32-42. The spiral groove runs the length of the cylinder and thus reduces the undesirable effects. In addition, since the spiral groove is continuous, it maintains an appropriate single electrode (26) on the outer surface. In this manner only two electrode lead connections need be made to the active element, one to the inside electrode and the other to any one of the electroded threads (since they are all electrically connected). Accordingly, the outer surface of the cylindrical transducer is helically cut, but maintains a single electrode requiring a single electrical connection. This device produces an omnidirectional beam pattern in a direction substantially perpendicular to the cylindrical transducer longitudinal axis.

Conversely, the present invention relates to a method for making a device assembly and tissue ablation transducer having a plurality of elements that can be operated out of phase to orient the acoustical energy beam forward or backward in the longitudinal direction, i.e. at angles relative to the cylindrical transducer longitudinal axis. This is accomplished by machining the metal coated ceramic tube to form a plurality of functionally discrete transducer segments, each having their own separate electrical connection.

As disclosed in Gingerich, a single cylindrical ultrasound transducer will produce a highly collimated acoustic energy beam that emanates from the transducer in a direction substantially normal to the transducer longitudinal axis. Similarly, several serially arranged cylindrical transducers placed along a longitudinal axis operated in phase produce adjacent collimated energy beams. However, it has been found that longitudinally arranged (serial) cylindrical transducers operated out of phase orient the acoustical energy beam forward or backward in the longitudinal direction. One problem with this configuration is the undesirable length of the longitudinally arranged cylindrical transducers.

The present application discloses, a transducer (and method for making the same) having a plurality of helical segments arranged serially along a longitudinal axis. When driven in-phase with respect to one another, the helical elements produce a highly collimated acoustic energy beam normal to the transducer longitudinal axis. However, when the helical segments are driven out of phase from one another, as illustrated in Figure 7A, the resultant cumulative acoustic energy beam emanates from the transducer 700 at an angle relative to the longitudinal axis. By varying the phase delay of the input signal 720, the acoustical energy beam angle will change. The implication is that for a different acoustic energy beam angle, a different phase delay would be used.

The outer electrode made by the inventive method is segmented by etching grooves into a small number of intertwined individual helical elements having a plurality of turns. Each individual element is substantially electrically insulated from the other elements, allowing the segmented elements to operate independently. This configuration in effect essentially forms an array of helically shaped functionally discrete transducers arranged linearly along the

longitudinal axis. Hereinafter, these apparent functionally discrete transducers will be referred to as transducer segments.

Conversely, in Gingerich the electrode on the outer surface is not separated into functionally discrete segments. Instead, an inventive feature of the Gingerich configuration allows the helically sliced and diced outer electrode to operate as a single electrode requiring only a single electrical connection. In addition, unlike the transducer element disclosed in Gingerich, each functionally discrete transducer segment in the present application has its own connection pad and electrical connection. This allows each transducer segment to be operated out of phase, allowing the transducer to achieve a phase coherency equal to many more individual serially phased transducers placed axially along the longitudinal axis. In fact, Gingerich teaches away from this arrangement, stating that a problem it seeks to overcome is the multitude of isolated elements or posts that could require multiple (several thousand in some cases) electrode connections.

For the purpose of example, Figures 4A through 4C of the present application show a transducer 400 having an outer electrode 404 sectored into five (5) elements 405 (405a through 405e) corresponding to five (5) discrete transducer segments 400a through 400e. Each transducer segment 400a through 400e encompasses twenty (20) turns, providing the phasing coherency of approximately one hundred (100) separate phased transducers arranged serially along the longitudinal axis 410. This is the true advantage of the device made by the present method.

For the reasons stated above, Applicant respectfully asserts that the cited method disclosed in Zhang in view of Gingerich does not include all the claim limitation in independent

Claim 1. In particular, Zhang in view of Gingerich does not disclose machining a metal coated ceramic tube to form a plurality of helically intertwined outer electrodes where each outer electrode is associated with a functionally discrete transducer segment. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejection of Claim 1 under 35 U.S.C. § 103(a). Claims 4, 5, 15 and 16 depend directly or indirectly from independent Claim 1. As a result, Zhang in view of Gingerich also fails to teach all the claim limitations of these dependent claims. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claims 4, 5, 15 and 16 under 35 U.S.C. § 103(a).

With regard to Claim 14, the Examiner asserts that Gingerich discloses a backing member, such as a foam plug, provided to act as a supporting means for the cut cylinder. The Examiner further alleges that since the element is thin-walled and requires a foam plug for support after the grooves are cut, the thin wall would require support during the machining process. Without commenting on the Examiner's allegations, Applicant respectfully submits that for the reasons stated above, Zhang in view of Gingerich does not include all the claim limitation in independent Claim 1. As Claim 14 depends directly from independent Claim 1, Zhang in view of Gingerich also fails to teach all the claim limitations of this dependent claim. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claim 14 under 35 U.S.C. § 103(a).

Rejection of Claim 17 under 35 U.S.C. 103(a)

The Examiner has rejected Claim 17 under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (2002/0059708), in view of Gingerich et al. (4,135,109), and as further evidenced by Licari (Coating Materials for Electronic Applications).

The Applicant does not admit or deny the Examiner's arguments regarding Zhang or Licari. Instead, as put forth above, the Applicant has distinguished Claim 1 of the present application based on the Examiner's analysis of Gingerich. Claims 17 depends indirectly from independent Claim 1. As a result, Zhang in view of Gingerich, and as further evidenced by Licari, also fails to teach all the claim limitations of this dependent claim. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claim 17 under 35 U.S.C. § 103(a).

Rejection of Claim 2 under 35 U.S.C. 103(a)

The Examiner has rejected Claim 2 under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (2002/0059708), in view of Gingerich et al. (4,135,109), and as further evidenced by Koshal (Manufacturing Engineer's Reference Book).

The Applicant does not admit or deny the Examiner's arguments regarding Zhang or Koshal. Instead, as put forth above, the Applicant has distinguished Claim 1 of the present application based on the Examiner's analysis of Gingerich. Claims 2 depends directly from independent Claim 1. As a result, Zhang in view of Gingerich, and as further evidenced by Koshal, also fails to teach all the claim limitations of this dependent claim. Accordingly,

Applicant respectfully requests the Examiner withdraw the rejection of Claim 2 under 35 U.S.C. § 103(a).

Rejection of Claim 3 Under 35 U.S.C. 103(a)

The Examiner has rejected Claim 3 under 35 U.S.C. 103(a) as being unpatentable over Zhang et al. (2002/0059708), in view of Gingerich et al. (4,135,109), and as further evidenced by Koshal (Manufacturing Engineer's Reference Book), and further in view of Tomaru (JP06-120062), Corbett et al. (5,855,049), and Hiller et al. (20020136969).

The Applicant does not admit or deny the Examiner's arguments regarding Zhang, Koshal, Tomaru, Corbett, and Hiller. Instead, as put forth above, the Applicant has distinguished Claim 1 of the present application based on the Examiner's analysis of Gingerich. Claims 3 depends indirectly from independent Claim 1. As a result, Zhang in view of Gingerich, and as further evidenced by Koshal, and further in view of Tomaru, Corbett, and Hiller, also fails to teach all the claim limitations of this dependent claim. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claim 3 under 35 U.S.C. § 103(a).

Rejection of Claims 6 and 7

The Applicant could not find a rejection of Claims 6 and 7 in the Examiners Detailed Office Action. However, for the reasons stated above, Applicant has distinguished Claim 1 of the present application based on the Examiner's analysis of Gingerich. Claims 6 and 7 depend directly from independent Claim 1. As a result, Applicants respectfully assert that Zhang in view of Gingerich, and as further evidenced by Koshal, and further in view of Tomaru, Corbett, and

Hiller, individually or in combination, also fails to teach all the claim limitations of these dependent claims. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claims 6 and 7 under 35 U.S.C. § 103(a).

CONCLUSION

In view of the foregoing amendment and remarks, Applicant respectfully asserts that the present application is now fully in condition for allowance, and such action is respectfully requested. If any issues remain that may be addressed by a phone conversation, the Examiner is invited to contact the undersigned at the phone number listed below.

A Petition for a 1 Month Extension of Time, along with authorization to charge the petition fee to the Applicant's Deposit Account, are being submitted with this Amendment and Response. No additional fee is thought to be necessary to enter this Amendment and Response. If an additional fee is required, the Examiner is authorized to charge the Applicants' Deposit Account - Account Number 10-0750/BIO-5020USNP.

Respectfully submitted,

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